

Review

Local Public Works Management for Sustainable Cities: The United States Experience

Neil S. Grigg

Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO 80523, USA; neilg@engr.colostate.edu

Abstract: Most people in the world now live in urban areas and their shared quest for better cities is embodied in several Sustainable Development Goals of the United Nations. These indicate that successful cities need jobs, adequate housing stock, effective governance, and other support systems. At the most basic level, they need a basket of core public works services like clean water and efficient transit, among others. These must be provided to improve public trust in government by addressing equity and affordability while also improving operational and cost efficiency. These targets are moving as transitions are occurring from stove-piped to integrated services, even while social contracts between government and the private sector are also shifting. Essential tools to improve cities include urban planning and infrastructure development, but applying them effectively faces challenges like climate change, inequality, social disorder, and even armed conflicts. This paper focuses on seven core public works services for drinking water, wastewater, stormwater, trash collection, mass transit, streets and traffic control, and disaster management. It reviews how these have evolved in the US, how they are organized under the federalism system, and how the goal of integrated management is being pursued. Challenges to integrated approaches include increasing responsibilities but lack of funding, political stress, and rule-driven and internally oriented management. Methods for performance assessment are explained under legacy systems based on methods like indicators and benchmarking applied to public works systems. Current methods focus on regulatory targets and the details; information has been shallow and not always timely. This paper projects how the performance assessment of core public works systems can be broadened to address goals like those of the SDGs and assesses why it is difficult to rate major systems. Examples of the activities of NGOs are given and an example of how progress toward SDG6 is included to show why performance management of integrated management applied to linked systems is needed. Performance dashboards with open government are currently the most common pathways, but emerging methods based on data analytics and visualization offer new possibilities. Reviewing the status of public works management shows that it is an important branch of the field of public administration, and it can be presented as a professional field with its own identity. The findings will support educators and researchers as well as provide policy insights into public works and stakeholder engagement.



Academic Editors: Chia-Yuan Yu and Jianming Cai

Received: 13 February 2025

Revised: 19 March 2025

Accepted: 21 March 2025

Published: 25 March 2025

Citation: Grigg, N.S. Local Public Works Management for Sustainable Cities: The United States Experience. *Urban Sci.* **2025**, *9*, 96. <https://doi.org/10.3390/urbansci9040096>

Copyright: © 2025 by the author.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: public works; public administration; urban systems; modeling; performance assessment

1. Introduction

Public works infrastructure and services provide essential support for cities around the world. Unless they are developed and managed well, visionary goals like those of

livable and healthy cities [1,2] cannot be achieved. Sustainable Development Goal (SDG) 11 expresses many of the goals, “Make cities and human settlements inclusive, safe, resilient and sustainable” [3]. These rely on integrated approaches to meet targets involving housing, transport systems, disaster risk management, and environmental impact, among other social issues [4]. Basic services like water, electricity, and waste management are needed for these, as well as other SDGs [5].

The focus of this paper is on a set of seven local public works services that provide the essential support for SDG 11 goals. They were selected because they have proved essential in cities and are generally managed under units named public works, public services, or similar titles. Organization of such services varies among settings but in the US, their grouping into local utilities and public works departments is the dominant form of service delivery. They include water, sanitation, stormwater, trash collection, transit, streets and traffic controls, and disaster risk management. Wastewater services represent the sanitation category to focus on removal of used water, rather than the hygienic facets of sanitation. Grouping these services into the category of local public works sets the stage to manage them as an integrated group because they can be managed under one umbrella agency.

As a classifier of public services and infrastructure, public works can mean different things. In some places, it is thought of mainly as a tool for job creation and without a special focus on effectiveness of service delivery [6]. Sometimes public services like schools, hospitals, and libraries are included as public works but in this paper, only the seven basic local systems mentioned are considered.

Some may think that public works services are low-technology systems, but the opposite is the case, with new applications of digital technologies and information-based devices in rising usage. These are needed to sustain and improve management of legacy infrastructure systems, which require careful attention to operations and asset management. While the topic of technology is compelling for public works managers, a detailed discussion of it is beyond the scope of the paper.

The main part of the paper is an assessment of public works management in the United States, where these categories of systems and services are often combined as public works to support social and economic goals like those in the SDGs [7]. Public works management is a branch of the field of public administration [8,9] and it shares the same governance climate [10]. The US has a long record of adjusting its institutions for public administration in its federal system. This will, of course, vary in other countries that do not practice a federal form of government, or which have adopted different delivery models for public services. A brief discussion of national public works is included, but the focus is on the local level. For example, the Army Corps of Engineers manages the inland waterway system and dam and lock systems [11]. The other part of the paper comprises a general discussion of methods to assess the outcomes of local public works delivery, without reference to a specific country.

Public works managers utilize tools like planning, innovative finance, economic development, and development of innovative infrastructure [12]. These tools are normally applied by government departments with names that indicate the functions involved, such as engineering, utilities, transportation, or stormwater. Disaster risk management responsibilities are shared with police, fire, and emergency medical, among other functional areas. It draws from the other core services, like rapid response to restore water supply service after a disaster.

The first topic addressed is the dominant organizational form of public works in the US, how it evolved, and how the allocation of responsibilities among the three levels of government was developed under federalism. This creates a baseline for the second topic, which is to analyze and report on how local public works managers can support integration

among urban subsystems, such as the economy and social life. Such integration supports the cooperative work of local planning and related agencies in shared arenas like health, recreation, and the urban environment. As public works management makes the transition from stove-piped to integrated services, new ways to measure performance are needed to assess how its outcomes align with needs like the SDG categories. This topic is used to explain the complex issue of measuring how public works support social issues of equity and affordability, while also improving operational and cost efficiency.

The data for the paper come from reports and research about public works management in the US and other countries and from the writer's records from work with local, state, and federal public works agencies and commissions, international public works tours and exchange visits, and focused teaching and research about public works management. The exchange visits in several countries of Europe, Latin America, and Asia have strengthened the data used to make comparative analyses in the paper. A core part of these experiences was derived from the writer's term as the Education Director on the Board of Directors of the American Public Works Association (APWA).

The paper demonstrates the use of a systems approach to explain public works integration and its value to society. A road map for building organizational and management capacity as technology changes is also presented. The paper provides policy insights for public works and stakeholder engagement, offers US experiences for use in benchmarking in other settings, and supports educators and researchers in public works administration and engineering by identifying topics for instruction and research. The combined result aims to improve public trust in government services by clarifying the support provided to cities by public works.

2. Urban Public Works Systems

The need for public works services is increasing as the world's population continues to urbanize, creating more pressure on cities. The fraction of people living in cities is highest among wealthy countries, but urban problems show similarities across all income groups. In the US, some 83 percent of people live in cities and essentially all population growth is urban [13]. Economic, social, and environmental challenges in US cities range across topics like affordable housing, crime, homelessness, and infrastructure, with cost of living heading the list [14], and similar challenges are experienced globally [15]. Policy makers and public administrators seek solutions in situations that are complex and difficult and require a better understanding of systemic interactions.

One tool to explain these interactions is provided by planning studies, which began before 1900 [16]. With the emergence of computers and the discipline of systems thinking, the interacting subsystems of cities provided an attractive subject for the work of a range of disciplines and new niche groups, like urban economists and geographers, infrastructure engineers, and urban ecologists. Such groups use systems views to form a comprehensive picture of the interaction among cities, their subsystems, and their interacting elements at several levels. The goal of such efforts is to achieve a comprehensive understanding of urban dynamics so the needed support systems can be provided.

The search for effective urban models grew as urbanization increased in the US after World War II. In the 1970s, Professor Jay Forrester showed how to apply his method of industrial dynamics to city problems with a book titled *Urban Dynamics* [17]. Now, many studies using systems dynamics methods to study cities have been published. While such modeling is useful, the need for an interdisciplinary approach and broader thinking is evident. At a 1997 US National Science Foundation workshop on urban interactions [18], participants noted how rapid demographic changes and shifting states of human and natural environments indicated that complexity has outrun researchers' ability to understand

them. They grappled with shifting roles of urban infrastructure and identified the need for improved statistical and modeling techniques and better data. Participation of citizens was recognized as a special challenge in urban communities with inadequate political institutions and poor social capital.

The complexity of cities challenges the success of urban systems models at a comprehensive level. Policies and decisions in city governance are not made by the use of such systems models, although the models can provide useful insight. Cities are socio-technical systems, and their models cannot simulate their many interactions with much validity, although subsystem models can come closer to reality [19,20]. The failure at the comprehensive level but success at the subsystem levels suggests that skeletonization can be used to conceptualize the big picture and subsystem models can be used to explore details [21].

A skeletonized view of urban systems must start at a high conceptual level to show how public works support built (physical), social, and natural systems. Figure 1 provides such a conceptual view with public works at the center to show its connections to all three urban systems. Public works support the built environment in basic ways as they provide services for social systems, which provide support to sustain it via economic and social means. The built environment also provides protection to natural systems, which provide ecosystem services to physical and social systems. Public facilities comprise about one-third of the built environment, based on construction in place [22]. However, these include facilities for public services not included in public works, like public libraries or hospitals, for example.

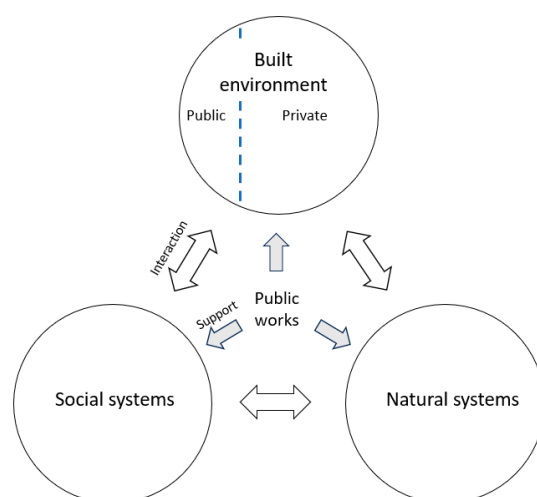


Figure 1. A skeletonized view of the urban system.

The primary urban systems of most concern to mayors are implicit in the interactions of the three systems shown and are dependent on core public works. They include economic development, infrastructure, health, energy and environment, housing, and public safety [23]. The mayors also identified concerns which link to public works management capacity, including budgets, data, and technology. Similar concerns are evident in the SDG categories [5] but tend toward the social needs of housing and shelter, and poverty, the economy, energy, food, environment, and justice.

Many types of actions occur within the organizing spaces for economic, social, and governmental activities shown in Figure 1, as well as with natural environmental elements. Examples include business activities, the movement of people and goods, material flows like water and energy, environmental changes and pollution, and cultural shifts. These create cross-impacts on the subsystems. For example, cities attract migrants to stimulate growth, but they may decline, shrink in population, and/or experience legacy infrastructure

and social problems. Whether they are growing, stable, or shrinking, cities experience problems such as housing, traffic congestion, pollution, health challenges, crime and social disorder, and inequality [24].

With increasing computational power, the conceptual model of Figure 1 can be developed with greater detail. However, with increasing detail, modelers must focus on subsystem levels. Current literature shows such models emerging to explain land use [25], physical systems like transportation [26], and social systems [27]. Systems tools to combine such models and develop more comprehensive approaches are becoming available via frameworks like the SysML modeling language [28] combined with engineering studies [29] and new applications of social theories [27].

3. Organization of Public Works Management in the US

The US public works sector is complex to define and classify due to the mixture of activities and shifting nature of the delivery of services. The term public works may not be used by a city, although the same services and facilities will be in place. APWA explained that public works are difficult to define because the structure of management departments varies and there is not a single ideal organizational structure. The association adopted the definition that public works are the "... the combination of physical assets, management practices, policies, and personnel necessary for government to provide and sustain structures and services essential to the welfare and acceptable quality of life for its citizens". It explained that "absence of these essential services would be injurious to public health and welfare" [30]. This explanation aligns with the SDGs and the need to address human needs at the most basic level, as in the Maslow hierarchy of human needs [31].

While public works may be difficult to define, people have always needed the systems and facilities they provide. Prominent historical examples include Roman roads and structures and Napoleon's public works construction program, for example. In the US, the US Army Corps of Engineers began its role in 1775 with works like river navigation, and the government then began to build or sponsor systems for water, energy, transportation, and other systems [11]. The US became an urban nation in the 20th Century, and the post-war boom accelerated the trends toward urbanization, with greater emphasis on local public works. During the 1950s, the focus of public works was on economic benefits, and the environmental emphasis developed during the 1970s, with social benefits receiving more emphasis later [32].

Public works can be explained within the economic concept of public goods and can include all types except private goods. They can involve utility or transit services which are toll goods, they can be common goods like management of a reservoir, or they can be pure public goods like flood control or environmental protection [33]. These classifications can be disputed, however. For example, some may argue that toll goods, like the supply of drinking water, should be considered public goods in recognition of human rights.

General discussions of public works tend to create ad hoc groupings. In the 1970s, Stone [9] identified 18 categories across levels of government responsibilities. The Infrastructure Report Card published by the American Society of Civil Engineers (ASCE) currently tracks 17 categories [34]. Of these, some are mainly at the national and state/regional levels and some at local levels. They are not clustered into sectors. For example, within ASCE's 17 categories, seven are part of the transportation sector and five are part of the water sector. That leaves five in a miscellaneous category, schools, solid wastes, hazardous wastes, energy, and parks.

Difficulty in classifying public works is a problem that also afflicts government activities in general. The core public works addressed in the paper are part of a larger group that includes systems, facilities, and services. This creates a public works sector that spans

government, construction, and utilities, which are designated industrial sectors in the US and used in economic accounting. The government sector is named “public administration” and is the only one of 22 sectors not included in the national economic census. Government departments like the civil works part of the Corps of Engineers are defined as “establishments of federal, state, and local government agencies that manage public programs and exercise authority over other institutions within given areas” [35].

The North American Industrial Classification System (NAICS) bifurcates public works by listing governmental programs in one category and some public works, such as airports, in other categories [36]. This reflects activities of public–private partnerships (PPPs), which are frequently used in public works management. This crisis of identity reflects a trend for public works to change with technology and with programs such as “reinventing government” [37]. APWA [30] also explained that public works services are usually delivered by governments, but if they are outsourced, they are still public works. Public utilities, like water, gas, electricity, and mass transit may not be owned and operated by a government agency but they involve the public interest and are regulated and are public works.

Despite the difficulty in classifying and explaining the public works sector, its leaders saw the need for capacity-building decades ago. The lack of a comprehensive federal public works agency meant that technical personnel were appointed without preparation [9,38]. In a partnership between APWA and the National Association of Schools of Public Affairs and Administration (now the Network of Schools of Public Policy, Affairs, and Administration), a project for graduate education in public works management was launched and the need was affirmed by the International Institute of Administrative Sciences [9]. The project succeeded in building capacity among a cohort of public works directors, but its subsidies expired, and it has been discontinued.

4. Dependence of Urban Subsystems on Public Works

Cities have many economic, physical, social, and environmental subsystems that depend on public works. The Maslow diagram [31] for the hierarchy of human needs can be used to explain these dependencies at a high conceptual level. As shown in Figure 2, the seven public works services shown on the right of the diagram are aligned with levels at the bottom of the diagram, from the physiological and safety levels up through to the social category at the third level. The concerns of the mayors mentioned earlier, that are shown on the left, also align with the lower part of the diagram.

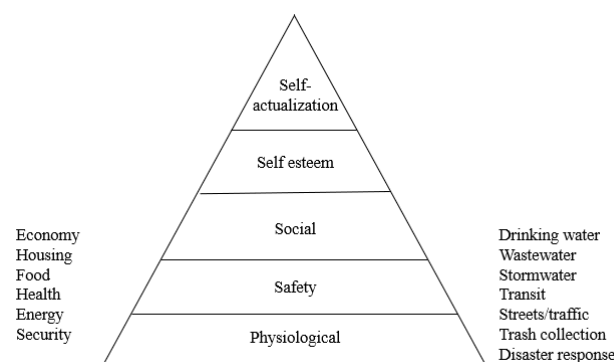


Figure 2. Maslow’s hierarchy with public works and linked urban systems shown.

Modeling approaches aim to simulate these interactions and use different methods with different levels of detail, from conceptual diagrams to quantitative models. Early models like Urban Dynamics [17] paved the way for the definition of systems at a high level, but they were not able to accommodate enough variables and details of datasets to be realistic. Emerging datasets offer the hope that approaches based on SysML and the

Unified Modeling Language (UML) [28,39] or versions of Systems Dynamics [40] can be used to overcome problems of granularity and data. Different model perspectives can shine lights on new issues as well, an example being the use of material flow models to show the metabolism of cities and illustrate food, energy, construction materials, water, and wastes fluxes [41].

Conceptual models are more useful than quantitative models to explain interactions to a wider audience involving stakeholders and policy makers. An example focusing on the economy and public works is shown in Figure 3. Similar examples can be developed for energy, environmental, housing, health, security, and information subsystems, as well as other critical subsystems. While the diagrams are simple, they provide the first step in explaining the issues of interdependence.

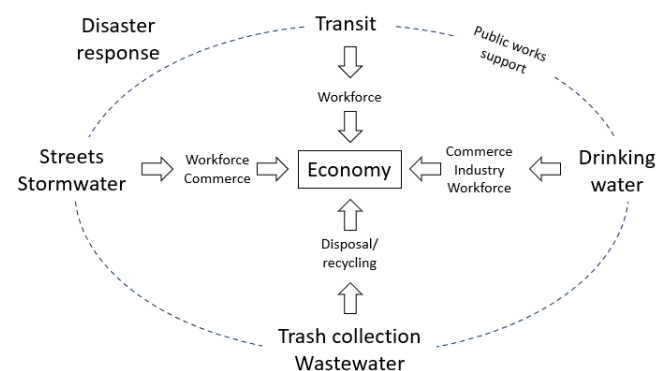


Figure 3. Example of the interaction between public works and the economy.

In Figure 3, streets and traffic control, along with stormwater, are shown in support of commerce and workforce transport. Drinking water supports industrial and commercial purposes and consumption at workplaces. The products of business and industry require disposal of trash and wastewater. Disaster response ensures that emergency systems work so that business and commerce can continue despite disasters.

5. Integration and Coordination of Public Works

Achieving integrated management of public works to address the needs of multiple urban systems requires coordination in planning and development. Its benefits are expressed in the slogan “the whole is greater than the sum of the parts”. This is also explained by complex systems theory by the concept of emergence, which indicates that unexpected benefits may develop from coordination that addresses interdependences among urban systems and creates mechanisms for integrated management [42].

Coordination is the heart of integrated management, which is often expressed as an aspirational goal. The need for it is explained often in the context of cities, such as in SDG 11 and its target 11.b, which aims at integrated policies and plans [4]. The benefits of coordination can be seen in examples of co-benefits between purposes. For example, green streets mix environmental and social benefits, while providing for economic purposes [43]. Efficiency gains also result from integrated management [44].

The need for coordination occurs across the categories of public works. For example, drinking water is a basic commodity, but it has secondary effects because without it, people cannot stay healthy, and businesses cannot function. Transit moves people from one place to another, but it also serves education, markets, and employers. Effective management of streets provides for transportation, stormwater runoff, children playing on sidewalks, and additional social benefits, like walking dogs and other recreation.

In urban planning, coordination involves joint work to organize actions to achieve common goals. These can be voluntary, through cooperation, or they can be mandated. If

the goals involve creative actions, then collaboration for shared creation is needed and, in all cases, good communication is required. These terms lead to the four “Cs”, communication, coordination, cooperation, and collaboration [45,46].

Local–regional coordination is often beneficial, usually coordinated by intergovernmental agreements [47]. Studies indicate that such interjurisdictional relations can be cooperative, competitive, or non-existent. For example, they are competitive in policies like economic development and taxation [48]. They can be cooperative when it is mutually advantageous to work together [49]. In the US, the Advisory Council for Intergovernmental Relations (ACIR) was created to work on cooperation, but it has been terminated due to political conflicts [50].

Whether coordination is cooperative or mandated, providing it requires public–private approaches as well as collaboration between governments. Private sector cooperation is needed to support public works actions, and some urban systems are managed under public–private arrangements. For example, governments can take substantial responsibility for public safety and environmental protection, but economic development and housing require significant private sector involvement. Public–private partnerships are often involved in the management of public works, as well as in fostering related economic activities [51].

In the US, the overall governance model of federalism offers a history of promoting intergovernmental coordination, mainly at the federal level. The status of intergovernmental relations in the US is “cooperative, conflictual, competitive, collusive, and coercive”. In public administration and the daily operations of government, intergovernmental relations are generally cooperative, but Congress has enacted many mandates and regulations that affect them [52].

Coordination is expressed in multiple directions as it requires horizontal and vertical work between and among levels and types of government agencies. It can involve relationships between federal and state governments, state and local governments, regional entities, local jurisdictions, departments of local governments, and sections within the departments. Forms of it can be evident in meetings, communications, joint presentations, and in other ongoing activities.

Planning and budgeting require cooperation and coordination between departments in a city because multiple issues are involved [53]. Multiple types of planning are involved. Strategic urban planning sets goals and growth policies for a city or metropolitan area. Land-use planning focuses on regulations, rules, codes, and policies because the private sector drives new initiatives for it. Master planning is used for systems like transportation and utilities [54].

As an example, in the city of Fort Collins, Colorado, among 58 department listings [55], the ones closest to public works are Building Services, Community Development and Neighborhood Services, Natural Areas, Park Planning and Development, Emergency Preparedness, Engineering, and Environmental services. These departments are coordinated through seven areas of strategic planning and budgeting for outcomes set by the City Council [56]. These areas are High Performing Government, Culture and Recreation, Economic Health, Environmental Health, Neighborhood and Community Viability, Safe Community, and Transportation and Mobility. By setting budgets through a coordinating process called Budgeting for Outcomes (BFO) [57], policy makers have a tool to foster cooperation.

There are various barriers to cooperation and coordination in local government services [58,59]. For example, surveys show that local governments have been assigned many tasks, but funding has not followed and this creates “unfunded mandates”. Politics and political stress causes pressures that can inhibit coordination. Also, rule-driven and internally oriented managers can block cooperation that requires a policy-oriented approach like BFO. While BFO is a promising concept, the intended coordination and integration require

additional analysis, preparation of materials, and may be more difficult to understand than traditional line-item budgets.

6. Outcomes/Performance of Core Public Works in the US

Assessment of the performance of public works systems in the US has received much attention, but the focus is on efficiency and cost control, rather than broader social and environmental goals. A review of the lessons learned can help to explain the best practices and to identify prospects to expand methods to comprehensive systems. Current methods focus on regulatory targets and the details of subsystem operations rather than on impacts on major system goals like the SDGs. However, prospects to assess them and map their performance to comprehensive sustainability goals have improved.

The development of metrics to assess the outcomes of public works management has accelerated during the last few decades of the 20th century [60]. This was in conjunction with application of performance measurement at all three levels of government and in private nonprofit organizations [61]. However, the information provided is often shallow and not timely. The main reason for these limitations is the focus on readily measurable quantities like, for example, power consumption of a treatment plant. Such details are relevant, but the information might not be of much use on a continuing basis. Advances that pave the way for significant improvements focus on the emerging capacity of data analytics.

Ratings of public works systems are fragmented among the distinct services, levels of government, and NGOs that may compete for attention. For example, the US Environmental Protection Agency (USEPA) rates the performance of drinking water, wastewater, and stormwater systems. The Federal Transit Administration [62] rates transit and the Federal Highway Administration [63] rates the performance of roads, but not traffic control and streets. On an overall basis, infrastructure performance is rated by the ASCE. The Corps of Engineers and state agencies rate dam safety, which is also reported by the Association of State Dam Safety Officials.

As an example of ratings for individual systems, the assessment of drinking water according to the USEPA is that the US has “one of the world’s most reliable and safest supplies”. Metrics for the national system are provided via the Safe Drinking Water Information System, through which anyone can send a query to learn the monitoring information about their drinking water safety [64]. However, this positive assessment masks issues with access that involve housing and local plumbing systems [65]. Also, drinking water public health crises like in Flint, Michigan and in Jackson, Mississippi have caused significant concern about the reliability and safety of drinking water, and one may learn about them mainly via the media [66].

As another example, among local public works, transit has the greatest interface with social issues in communities because it is essential for access to jobs, schools, shopping, healthcare, and other essential destinations for many people. The ASCE [33] assigned a D- grade to transit in 2021 and reported that some 45% of Americans lacked access to it, while existing systems suffer from aging and lack of funding for system renewal. Ridership fell to just 20 percent of pre-pandemic levels in April 2020, but by 2024 it had recovered to 79 percent of those levels. Most of the recovery has been due to younger bus riders, and the rates are strongly dependent on types of jobs, job locations, and other economic drivers [67]. The performance of US transit systems might be improved by comparison with European systems, which tend to perform better [68].

Performance assessment methods are well-developed for application to structured subsystems like, for example, the frequency of trash collection. The perspectives are of users and system managers, who ask, “how well do the systems meet my needs” and “how

well do they operate?”. Assessment also involves the performance of the infrastructure and of the management systems.

The general framework is one of continuous improvement. The achievement level of a system’s characteristic activity is given a score and then compared to a goal and to a benchmark. Depending on how well the achievement compares to the goal, continuous improvement programs are established and implemented. This is similar to quality management programs in industry, which are well established and based on studies in industrial management and quality control.

Performance is measured at different subsystem levels and at higher system levels; measurement involves more metrics and more aggregation of information. This is the same problem described for business organizations, where performance management is challenging because each management level views operations through a unique lens [69]. For example, a water supply system, as one part of a public works system, will involve infrastructure and management systems. Levels of the water supply system will include source, treatment, and distribution. Each of the levels can involve metrics focused on subsystem performance, but it is challenging to aggregate the information into meaningful comprehensive indicators.

The disaggregation of systems for performance measurement creates stovepipes where individual performance targets can be assessed. For example, the percentage of time that a water system delivered adequate pressure or the hours per year of a level of traffic congestion can be measured. Metrics of this type are explained in [70]. Aggregating such metrics should lead to performance assessment of higher-level systems, like in the ASCE infrastructure report card [33]. The grades that it provides, however, can be judged as subjective, as in the drinking water grade of C- in 2021.

The difficulty in rating an entire system, like in the drinking water example, stems from perspectives at different levels. Taking the assessment to the next step, the focus shifts to how a service has performed in supporting a linked urban system. For example, how well did drinking water support housing goals? This requires embedding the drinking water goal into the housing goal by exploring things like the “percentage of houses with adequate drinking water”. This quickly becomes systemic as the number of metrics increases.

The focus on the social needs of SDG11 is evident from its targets, which include [5] housing and upgrading slums, transport systems, and participatory human settlement planning, among others.

This makes assessment more difficult because, for example, clean water and sanitation, zero hunger, and no poverty address diverse and existential needs of people, which may create controversies over differing value concepts.

In the US, codes of professional ethics in public works management embrace the spirit of the social focus of the SDGs. For example, these include environmental justice [71] and social equity [72]. The challenge is, as always, implementing visionary concepts in the real world of decision-making and conflicts over issues like budgeting and distribution of resources.

7. Discussion: How Well Do Public Works Support Urban Systems?

The seven basic urban services discussed are critical to economic and social systems in cities, and public works management has proved an effective framework and mechanism to deliver them when it receives support and is governed well. Going forward, urbanization and challenges like poverty, migration, and climate-induced disasters will challenge public works in cities to meet social needs among disenfranchised income residents. Social systems linked to public works are especially critical, as shown by the concern of mayors about

housing, security, health, and human services. These problems are exacerbated when conflicts over the public or private delivery of services are involved.

If core public works services are splintered among various organizational and management entities, they are more difficult to coordinate and integrate and this will impair their effectiveness in meeting all needs. Employee mobility from one service to another can be hindered and this can impede transfer of knowledge and capacity-building, especially for critical skill sets like technical knowledge, service orientation, public involvement, and asset management, among others.

While good governance, adequate financing, and effective public works management can improve delivery of services for urban residents, the social contract between cities and their stakeholders may shift as cities struggle to support core services and the linked social systems. Trends toward privatization, outsourcing, and cost-cutting are understandable, and integration of core public works services can help cities to focus on their importance and performance. This will require focus on human rights and related social justice issues. Public-private partnerships can help, and the US has many not-for-profit non-governmental organizations ready to cooperate in aspects of public works delivery.

The US experience shows that public works management can function effectively in a democratic and federal system of government with roles for three levels of government and with most services delivered at the local level. This is consistent with the concept of subsidiarity, which is an accepted principle of governance and has been adopted specifically by the European Union [73]. How subsidiarity works differs among political systems and may involve different terminology [74,75]. If countries do not practice subsidiarity, their chances of successful intergovernmental management will be reduced.

This form of public works delivery in the US, that works in a federal system and with subsidiarity, evolved through trial-and-error experiments. The US was once a developing country, and it made sense that large-scale systems were built and managed by the federal government, with responsibilities allocated among the levels based on scale and national interest. The federal government manages large-scale systems with national security implications like inland navigation and large dams, state governments have key roles in intercity transportation, and local governments deliver utility and other services directly to residents.

Federal and state governments play important roles in regulation and transfer payments, which can foster integration and shifts from stovepipes to integrated services. Non-governmental organizations can help as they play key roles in policy advocacy and capacity building, among others. That reality may be changing due to shifting responsibilities and fiscal needs. Public works management arrangements in cities and in regional settings indicate the need for entrepreneurial experiments in institution-building. An example is a collaborative in Denver, Colorado that is addressing regional water supply [76].

Among cities larger than around 10,000 residents, the bundling and integration of public works services are evident. APWA is taking a lead role in advocating integrated public works management toward sustainability [77] and AWWA is leading the integration of water, wastewater, and stormwater into One Water groups [78]. Streets and transit are parts of increasingly integrated urban transportation systems [79]. Solid waste management is linked to recycling and management of materials flow in cities such as reclamation of food waste [80]. Disaster risk management is an integrated service as it involves coordination among several types of agencies. Trends toward the bundling of services and integration are a work in progress and need help to overcome barriers like stovepipes, which are resistant to reform due to bureaucratic inertia, among other forces.

As policy makers seek reforms and strengthened management capacity, they turn to performance assessment, which begins with stove-piped indicators for separate services,

which can provide indicators that are shallow and not timely or useful. For example, regulated services require reporting to authorities, which establish standards and information for performance reports and these may not be very useful for continuous improvement. New ways are needed to assess how such indicators can support assessments of integrated systems and interactions among systems. However, public works involve multiple systems and levels, as well as interdependences, and the current system does not yet allow centralized master assessment systems to be organized.

In the US system, performance assessment of public works management systems takes place within the political dimension in a democratic system. City residents elect representatives based on their overall perceptions of how well things are going in the cities. Performance assessment is a shared responsibility, with emphasis on the involvement of the public and non-governmental organizations. The outcomes of system operations can be explained to residents through city dashboards and other media. At aggregated state and national levels, the ASCE Report Card provides overall assessments.

In complex cities, well-intended policies can have counter-intuitive effects. For example, a city can strive to be more welcoming to migrants and end up with financial loads that will require cutbacks in essential services to other stakeholders. Issues like this can be studied via urban systems modeling as a tool to identify interdependences and such counter-intuitive effects as indicators of policy reform.

Ultimately, public works management is part of the field of public administration, with emphasis on technical systems. Going forward, public works management should be defined as a professional field like utility management. Capacity should be created for a professional class of managers for critical services. They should be able to adapt new technologies and management tools and strive for continuous improvement within the climate expressed by the “reinventing government” movement [81].

Public works organizations can seek certification, such as through the APWA accreditation program with use of the Public Works Management Practices Manual [82]. Individual units can seek accreditation through other organizations, like AWWA’s Partnership for Safe Water [83].

8. Conclusions

The problems facing cities undergoing urbanization indicate how important effective public works systems are to support the social, economic, and environmental systems required to make progress toward the SDGs. A package of core public works services like clean water and efficient transit must be provided to improve public trust by addressing equity and affordability while also improving operational and cost efficiency. The core public works services analyzed make a good group to study because they are frequently grouped under public works or similar departments in the US.

The analysis of the US experience shows how public works management can be organized within a federal system. It took place at a time of rapid transition as services are changing from stove-piped to integrated delivery, even while social contracts between government and the private sector are also shifting. The lessons learned concern the importance of the local level of government, the value of sharing among peer organizations to improve performance, and the importance of searching for effective ways to integrate services and systems.

The US shows strong trends toward the embrace of performance assessment, but these methods require improvement to address goals like those of the SDGs. This can occur through open government, which is being “reinvented”, with new approaches and emerging methods based on data analytics and visualization. Specifically, the combination

of these new approaches with strategic planning that incorporates social justice goals can lead to new methods for goal-setting and decision-making.

The role of NGOs in providing quality control programs like organizational and individual certification, as well as continuous improvement programs, have proven pivotal to encourage management improvements. As governments reach their limits of financial resources and management capacity, many issues will be left to NGOs to partner with public agencies in meeting social needs.

The future of public works management will be challenging, as it confronts climate change, inequality, social disorder, and even armed conflicts, at the same time as funding and workforce capacities constrain public works organizations. Challenges to integrated approaches include increasing responsibilities but lack of funding, political stress, and rule-driven and internally oriented management.

Ultimately, public works management is an important branch of the field of public administration. As it reinforces its own identity as a professional field, future experiences will provide policy insights for public works, foster stakeholder engagement, and aid educators and researchers in advancing the field. Actionable items for education and research can include emphasis of public works management within public administration and engineering programs. For policy makers, the lessons point toward improved goal-setting and more comprehensive performance assessment. The final test for it will be the extent to which it increases public trust in the delivery of public goods and services. This test provides a focus on stakeholder engagement, which must be more than just perfunctory if citizens are to take interest and active roles in city improvement.

Funding: This research received no external funding.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Centre for Livable Cities. CLC Ltd. 2025. Available online: <https://www.clc.gov.sg/> (accessed on 12 February 2025).
2. World Health Organization. Healthy Cities. 2025. Available online: <https://www.who.int/southeastasia/activities/healthy-cities> (accessed on 12 February 2025).
3. United Nations. Department of Economic and Social Affairs. Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable. 2025. Available online: <https://sdgs.un.org/goals/goal11> (accessed on 12 February 2025).
4. United Nations. Department of Economic and Social Affairs. Goal 11. 2025. Available online: https://sdgs.un.org/goals/goal11#targets_and_indicators (accessed on 12 February 2025).
5. Colenbrander, S. Cities as Engines of Economic Growth. IIED. 2016. Available online: <https://www.iied.org/sites/default/files/pdfs/migrate/10801IIED.pdf> (accessed on 12 February 2025).
6. Zimmerman, L. Public Works Programs in Developing Countries Have the Potential to Reduce Poverty. *IZA World Labor* **2014**, *2014*, 25. Available online: <https://wol.iza.org/uploads/articles/25/pdfs/public-works-programs-in-developing-countries-have-the-potential-to-reduce-poverty.pdf> (accessed on 12 February 2025). [CrossRef]
7. Wesołowska, J. Urban Infrastructure Facilities as an Essential Public Investment for Sustainable Cities—Indispensable but Unwelcome Objects of Social Conflicts. Case Study of Warsaw, Poland. *Transp. Res. Procedia* **2016**, *16*, 553–565. [CrossRef]
8. Stone, D.C. *Professional Education in Public Works/Environmental Engineering and Administration*; American Public Works Association: Chicago, IL, USA, 1974.
9. California State University, Long Beach. Public Administration, Public Works Administration Option, M.P.A. 2025. Available online: http://catalog.csulb.edu/preview_program.php?catoid=5&poid=2083 (accessed on 12 February 2025).
10. Nelson, K. Returning to the Politics Versus Administration Debate. 2022. Available online: <https://icma.org/articles/pm-magazine/returning-politics-versus-administration-debate> (accessed on 12 February 2025).
11. American Public Works Association. *History of Public Works in the United States, 1776–1976*; American Public Works Association: Chicago, IL, USA, 1976.
12. Public Works Consultants. Improvements Through Technology. 2025. Available online: <https://publicworksconsultants.com/services/public-works-improvements-through-technology/> (accessed on 12 February 2025).

13. Ritchie, H.; Samborska, V.; Roser, M. Urbanization. 2024. Available online: <https://ourworldindata.org/urbanization> (accessed on 12 February 2025).
14. Parker, K.; Menasce Horowitz, J.; Brown, A.; Fry, R.; Cohn, D.; Igielnik, R. Views of Problems Facing Urban, Suburban and Rural Communities. 2018. Available online: <https://www.pewresearch.org/social-trends/2018/05/22/views-of-problems-facing-urban-suburban-and-rural-communities/> (accessed on 12 February 2025).
15. Chan Heng, C.; Neo, H. 5 Big Challenges Facing Big Cities of the Future. World Economic Forum. 2018. Available online: <https://www.weforum.org/stories/2018/10/the-5-biggest-challenges-cities-will-face-in-the-future/> (accessed on 12 February 2025).
16. American Planning Association. Planning history timeline. 2025. Available online: <https://www.planning.org/timeline/> (accessed on 12 February 2025).
17. Ulak, A. Diagrammatic Abstractions: Jay Forrester's Urban Dynamics and Its Contribution to Architecture and Urban Planning in the Late 1960s and Early 1970s. *Archit. Hist.* **2023**, *11*. [CrossRef]
18. May, T.; Perry, B.; Le Galès, P.; Sassen, S.; Savage, M. The Future of Urban Sociology. *Sociology* **2005**, *39*, 343–370. [CrossRef]
19. Brown, D.M. Understanding Urban Interactions: Summary of a Research Workshop. US National Research Foundation. 1997. Available online: <https://www.nsf.gov/pubs/1998/sbe981/sbe981.htm> (accessed on 12 February 2025).
20. Fabolude, G.; Knoble, C.; Vu, A.; Yu, D. Smart cities, smart systems: A comprehensive review of system dynamics model applications in urban studies in the big data era. *Geogr. Sustain.* **2024**, *6*, 100246. [CrossRef]
21. Arcaute, E.; Ramasco, J.J. Recent advances in urban system science: Models and data. *PLoS ONE* **2022**, *17*, e0272863. [CrossRef] [PubMed]
22. Hatidani, K.T.; Telukdarie, A.; Munsamy, M.; Tshukudu, C. Extraction of the essential elements for urban systems modelling—A word-to-vector approach. *City Environ. Inter.* **2024**, *24*, 100166. [CrossRef]
23. US Department of Census. Construction Spending. 2025. Available online: <https://www.census.gov/construction/c30/c30index.html> (accessed on 12 February 2025).
24. Rainwater, Brooks. The Ten Biggest Issues US Mayors Say They Are Tackling in 2019. 2019. Available online: <https://www.fastcompany.com/90363344/the-10-biggest-issues-u-s-say-theyre-tackling-in-2019> (accessed on 12 February 2025).
25. Rothenberg Pack, J.; Potter, S.R.; Gale, W.G. Problems and Prospects for Urban Areas. Brookings Institute. 2002. Available online: <https://www.brookings.edu/articles/problems-and-prospects-for-urban-areas/> (accessed on 12 February 2025).
26. Jing, W.; Li, G.; Lu, H.; Wu, Z. Urban models: Progress and perspective. *Sustain. Fut.* **2024**, *7*, 100181. [CrossRef]
27. García-Cerrud, C.A.; De La Mota, I.F. Simulation models for public transportation: A state-of-the-art review. *Proc. Comp. Sci.* **2023**, *217*, 562–569. [CrossRef]
28. Kimura, A.; Hisashi, H.; Yutaka, Y.; Katsuta, M. Social system design methodology for transitioning to a new social structure—a holistic urban living lab approach to the well-being city. *Front. Sociol. Sec. Sociol. Theory* **2023**, *8*, 1201504. [CrossRef] [PubMed]
29. OMG Systems Modeling Language. What is SysML? Available online: <https://www.omgsysml.org/what-is-sysml.htm> (accessed on 12 February 2025).
30. University of Michigan. Civil and Environmental Engineering. *Adapting to New Challenges*. 2025. Available online: <https://strategicdirections.cee.engin.umich.edu/direction/adaptation/> (accessed on 12 February 2025).
31. American Public Works Association. What is Public Works? 2025. Available online: <https://www.apwa.org/resources/about-public-works/> (accessed on 12 February 2025).
32. Grigg, N.S. Education and Research for Infrastructure and Public Works. *Public Work. Manag. Policy* **1996**, *1*, 120–128. [CrossRef]
33. Medical News Today. Maslow's hierarchy of needs: Uses and criticisms. 2022. Available online: <https://www.medicalnewstoday.com/articles/maslows-hierarchy-of-needs> (accessed on 12 February 2025).
34. Fair, R.C. US Infrastructure 1929–2023. 2025. Available online: <https://fairmodel.econ.yale.edu/rayfair/pdf/2019d.pdf> (accessed on 12 February 2025).
35. Chin, M. What Are Global Public Goods? *International Monetary Fund*. 2021. Available online: <https://www.imf.org/en/Publications/fandd/issues/2021/12/Global-Public-Goods-Chin-basics> (accessed on 12 February 2025).
36. American Society of Civil Engineers. Infrastructure Report Card. 2025. Available online: <https://infrastructurereportcard.org/> (accessed on 12 February 2025).
37. US Department of Census. Economic Census: NAICS Codes & Understanding Industry Classification Systems. 2025. Available online: <https://www.census.gov/programs-surveys/economic-census/year/2022/guidance/understanding-naics.html> (accessed on 12 February 2025).
38. US Department of Census. North American Industrial Classification System. In *United States*; 2022. Available online: https://www.census.gov/naics/reference_files_tools/2022_NAICS_Manual.pdf (accessed on 12 February 2025).
39. Greenough, G.; Eggum, T.; Ford, U.G., III; Grigg, N.S.; Sizer, E. Public works delivery systems in North America: Private and public approaches, including managed competition. *Public Work. Manag. Policy* **1999**, *4*, 41–49.

40. Asset works. The History of Public Works in the United States. 2025. Available online: <https://www.assetworks.com/eam/infographic/history-of-public-works-in-the-united-states/> (accessed on 12 February 2025).
41. Visual Paradigm. What Is Interaction Diagrams in UML? 2025. Available online: <https://guides.visual-paradigm.com/what-is-interaction-diagrams-in-uml/> (accessed on 12 February 2025).
42. Systems Dynamics Society. The Systems Dynamics Approach. 2025. Available online: <https://systemdynamics.org/what-is-system-dynamics/> (accessed on 12 February 2025).
43. Derrible, S.; Cheah, L.; Arora, M.; Yeow, L.W.; Urban Metabolism. In *Urban Informatics; The Urban Book Series*; Shi, W., Goodchild, M.F., Batty, M., Kwan, M.P., Zhang, A., Eds.; Springer, Singapore. 2021. Available online: https://link.springer.com/chapter/10.1007/978-981-15-8983-6_7 (accessed on 12 February 2025).
44. Barksdale, N. What is emergence? John Templeton Foundation. 2023. Available online: <https://www.templeton.org/news/what-is-emergence> (accessed on 12 February 2025).
45. US Environmental Protection Agency. Green Streets, Green Jobs, Green Towns (G3) Integrated Planning. 2025. Available online: <https://www.epa.gov/G3/green-streets-green-jobs-green-towns-g3-integrated-planning> (accessed on 12 February 2025).
46. Ferraresi, M.; Migali, G.; Rizzo, L. Does intermunicipal cooperation promote efficiency gains? Evidence from Italian municipal unions. *J. Reg. Sci.* **2018**, *58*, 1017–1044. [CrossRef]
47. Macfadden, M. The Four Cs: Communication, Coordination, Cooperation, and Collaboration. 2018. Available online: <https://convergencelabs.com/blog/2018/01/the-four-cs-communication-coordination-cooperation-and-collaboration/> (accessed on 12 February 2025).
48. West, S. The Evolutionary Benefits of Cooperation. The Leakey Foundation. 2016. Available online: <https://leakeyfoundation.org/the-evolutionary-benefits-of-cooperation/> (accessed on 12 February 2025).
49. Wänström, J.; Persson, B. Local governments on an equal footing? Policy coordination between Swedish regions and municipalities in regional development policy. *Reg. Fed. Stud.* **2023**, *34*, 733–756. [CrossRef]
50. Forum of Federations. Intergovernmental Relations in the United States of America. 2025. Available online: <https://www.forumfed.org/document/intergovernmental-relations-in-the-united-states-of-america/> (accessed on 12 February 2025).
51. Houghteling, S.; Scott, R.P. Do local governments compete or cooperate for resiliency? The case of state spending in Colorado. *Cities* **2023**, *140*, 104440. [CrossRef]
52. Administrative Conference of the United States. Improving Coordination of Related Agency Responsibilities. 2012. Available online: <https://www.acus.gov/document/improving-coordination-related-agency-responsibilities> (accessed on 12 February 2025).
53. Power in Partnerships: How City-County Collaborations Advance Economic Mobility. Available online: https://results4america.org/wp-content/uploads/2022/04/RFA_CCP-Power-in-Partnerships_03.04.22.pdf (accessed on 12 February 2025).
54. Stenberg, C.; Yatsco, T.; Kincaid, J.; Advisory Commission on Intergovernmental Relations. Center for the Study of Federalism. Available online: <https://federalism.org/encyclopedia/no-topic/advisory-commission-on-intergovernmental-relations/> (accessed on 12 February 2025).
55. Ende, J. 3 Ways to Strengthen Your Government Through Collaboration. 2018. Available online: <https://www.govloop.com/community/blog/3-ways-strengthen-government-collaboration/> (accessed on 12 February 2025).
56. Sailus, M. 7 Types of Urban Planning Concepts Explained. 2024. Available online: <https://www.clearpointstrategy.com/blog/types-of-urban-planning#7-types-of-urban-planning-concepts-explained-from-a-strategic-lens> (accessed on 12 February 2025).
57. City of Fort Collins. Departments. 2025. Available online: <https://www.fcgov.com/cityservices/> (accessed on 12 February 2025).
58. City of Fort Collins. Strategic Plan. 2025. Available online: <https://www.fcgov.com/citymanager/files/24-26321-2024-strategic-plan-document-v4.pdf> (accessed on 12 February 2025).
59. City of Fort Collins. Budgeting for Outcomes. 2025. Available online: <https://www.fcgov.com/bfo/> (accessed on 12 February 2025).
60. De Wulf, N.; Voets, J.; Molenveld, A. Policy coordination and integration in local government: Perspectives on barriers. *Policy Politics* **2023**, *51*, 530–549. [CrossRef]
61. Mukheibir, P.; Howe, C.; Gallet, D. Institutional Issues for Integrated ‘One Water’ Management. In *Water Environment Research Foundation, Water Research Foundation and Water Research Australia*; IWA Publishing: London, UK, 2015.
62. Hatry, H.P. Transforming Performance Measurement for the 21st Century. Urban Institute. 2014. Available online: <https://www.urban.org/research/publication/transforming-performance-measurement-21st-century> (accessed on 12 February 2025).
63. Rea, K. How to Evolve Federal Performance Management—And What’s Possible Right Now. Partnership for Public Service. 2024. Available online: <https://ourpublicservice.org/blog/how-to-evolve-federal-performance-management/> (accessed on 12 February 2025).
64. Federal Transit Administration. Performance Management. 2025. Available online: <https://www.transit.dot.gov/PerformanceManagement> (accessed on 12 February 2025).
65. Federal Highway Administration. Transportation Performance Management. 2025. Available online: <https://www.fhwa.dot.gov/tpm/> (accessed on 12 February 2025).

66. US Environmental Protection Agency Basic Information About Your Drinking Water. 2025. Available online: <https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-your-drinking-water> (accessed on 12 February 2025).
67. Mueller, J.T.; Gasteyer, S. The Widespread and Unjust Drinking Water and Clean Water Crisis in the United States. *Nat. Commun.* **2021**, *12*, 3544. [CrossRef] [PubMed]
68. LibertiesEU. Media reporting on environment What Is Watchdog Journalism: Definition, Examples, Effects on Democracy. 2022. Available online: <https://www.liberties.eu/en/stories/watchdog-journalism/43959> (accessed on 12 February 2025).
69. APTA. APTA Public Transportation Media Update. 2024. Available online: <https://www.apta.com/wp-content/uploads/APTA-POLICY-BRIEF-Transit-Ridership-04.01.2024.pdf> (accessed on 12 February 2025).
70. Bullen, Q. What the U.S. Can Learn from Global Transit Networks. 2024. Available online: <https://blog.keolisna.com/what-the-u.s.-can-learn> (accessed on 12 February 2025).
71. Follows, P. The Problem Behind the Problem: Measuring Performance. 2024. Available online: <https://www.forbes.com/sites/forbesbooksauthors/2024/06/10/the-problem-behind-the-problem-measuring-performance/> (accessed on 12 February 2025).
72. Ammons, D.N. Performance Management Research for State and Local Government: Where It Should Go Next. *State and Local Government Review* **2022**, *54*, 195–201. [CrossRef]
73. American Public Works Association. Ethics for the Public Works Leader. 2025. Available online: <https://www.apwa.org/resource/ethics-for-the-public-works-leader/> (accessed on 12 February 2025).
74. American Society of Civil Engineers. Code of Ethics. 2025. Available online: <https://www.asce.org/career-growth/ethics/code-of-ethics> (accessed on 12 February 2025).
75. European Parliament. The Principle of Subsidiarity. 2025. Available online: <https://www.europarl.europa.eu/factsheets/en/sheet/7/the-principle-of-subsidiarity> (accessed on 12 February 2025).
76. Vischer, R. Subsidiarity as a Principle of Governance: Beyond Devolution. *Indiana Law Rev.* **2001**, *35*, 103–142. [CrossRef] [PubMed]
77. Ditchley. Devolution and Subsidiarity: Relationships Between Central, Next-Lower Levels of National Government. 2000. Available online: <https://www.ditchley.com/past-events/past-programme/2000-2009/2000/devolution> (accessed on 12 February 2025).
78. Water Collaborative Delivery Association. Our History. 2025. Available online: <https://watercollaborativedelivery.org/history/> (accessed on 12 February 2025).
79. American Public Works Association. A New Vision for Public Works Management. 2025. Available online: <https://www.apwa.org/resource/a-new-vision-for-public-works-management/> (accessed on 12 February 2025).
80. American Water Works Association. One Water: Navigating the Financial, Legal, and Management Opportunities. 2025. Available online: <https://www.awwa.org/one-water-navigating-the-financial-legal-and-management-opportunities/> (accessed on 12 February 2025).
81. Local Government Utopia. Reinventing Local Government. 2024. Available online: <https://localgovernmentutopia.com/2024/01/08/261-reinventing-local-government/> (accessed on 12 February 2025).
82. American Public Works Association. Accreditation. 2025. Available online: <https://www.apwa.org/resources/accreditation/> (accessed on 12 February 2025).
83. American Water Works Association. Partnership for Safe Water. 2025. Available online: <https://www.awwa.org/programs/partnership-for-safe-water/> (accessed on 12 February 2025).

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.